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Editorial

Estuarine Management and Technologies: A way forward for estuarine research

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Estuarine ecosystems, situated at the confluence of freshwater rivers and the saline expanse of the sea, embody a unique and dynamic interface between terrestrial and marine realms (Figure 1). These ecosystems are not only teeming with diverse flora and fauna but also serve as vital contributors to the overall health of our planet. Estuaries are represented on all continents, and at almost all latitudes, hence the natural conditions and environments of estuaries vary in very wide ranges.As we navigate the complexities of the 21st century, marked by unprecedented environmental challenges, the significance of estuarine ecosystems in maintaining ecological balance cannot be underestimated.Biodiversity flourishes in estuaries, where the mingling of freshwater and saltwater creates a rich environmentof habitats. Mangrove forests, salt marshes, and tidal flats are among the ecosystems that characterize estuarine landscapes, providing sanctuary and breeding grounds for an array of species. These ecosystems act as nurseries for commercially important fish species, supporting fisheries that are crucial for global food security. Additionally, estuarine areas act as natural buffers, mitigating the impacts of storms and serving as filters for pollutants carried by river waters from upstream regions. In the face of rapid environmental changes and anthropogenic pressures, the need for effective estuarine management has never been more pronounced. Conservation efforts must go beyond traditional approaches and em-

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brace innovative strategies that leverage cutting-edge technologies. The integration of remote sensing, data analytics, and artificial intelligence can revolutionize our understanding of estuarine dynamics, enabling real-time monitoring and predictive modelling. This transformational approach empowers scientists and policy-makers to make informed decisions, fostering adaptive management strategies that respond dynamically to the evolving conditions of estuarine ecosystems.

Figure 1. Estuaries (Source: National Oceanic and Atmospheric Administration).

One crucial aspect of estuarine management is the sustainable use of resources to balance conservation with human needs. Striking this delicate equilibrium requires a holistic understanding of the intricate web of ecological interactions within estuarine environments. Advanced technologies, such asisotopic techniques, environmental DNA (eDNA) analysis, can provide insights into the biodiversity of estuarine ecosystems with unprecedented precision. This molecular tool allows researchers to detect and identify species present in a given area by analyzing environmental samples like water or sediment, offering a non-invasive and comprehensive way to assess the health of these ecosystems.Moreover, citizen science and community engagement play a pivotal role in estuarine management. Collaborative efforts involving local communities in monitoring and conservation initiatives can enhance the effectiveness of management strategies and foster a sense of stewardship among the people who directly depend on these ecosystems for their livelihoods.

The goal of Estuarine Management and Technologies is to facilitate collaboration and original research across all aspects of estuarine management, including but not limited to the following focus areas.

Importance of estuarine ecosystems

Estuaries function as crucial breeding grounds, fostering growth and reproduction of countless marine species and providing a habitat for diverse flora and fauna. They also play a vital role in nutrient cycling, carbon sequestration,

and mitigating the impacts of climate change. Recognizing the significance of these ecosystems is the first step towards developing effective management strategies.

Challenges in estuarine management

Estuarine ecosystems face an array of threats, including pollution, habitat loss, overfishing, and the impacts of climate change. Managing these challenges requires a multidisciplinary approach that combines ecological knowledge, policy development, and the utilization of innovative technologies.

Integration of advanced technologies

The future of estuarine management lies in the seamless integration of advanced technologies. Using sophisticated measuring devices, remote sensing, satellite imagery, and drones offer new perspectives for monitoring and assessing estuarine health. Big data analytics can provide valuable insights into complex ecological interactions, aiding in the formulation of evidence-based management strategies.

Environmental modeling for predictive management

Computational models, supported by artificial intelligence and machine learning algorithms, can simulate various scenarios and predict the outcomes of management interventions. These models can help decision-makers anticipate the impact of human activities and climate change on estuarine ecosystems, enabling proactive management.

Community engagement and stakeholder collaboration

Successful estuarine management requires collaboration among scientists, policymakers, local communities, and industry stakeholders. Engaging communities in citizen science projects and involving them in decision-making processes fosters a sense of responsibility and shared ownership of estuarine health.

Educational outreach and advocacy

Building awareness about the importance of estuarine ecosystems is crucial for garnering public support. Educational outreach programs and advocacy efforts can mobilize communities to participate in conservation initiatives, thereby creating a collective commitment to sustainable estuarine management.

Policy innovation and implementation

Effective estuarine management requires robust policies that balance ecological conservation with socio-economic development. Governments and regulatory bodies need to adopt forward-thinking policies that prioritize long-term environmental sustainability while promoting responsible resource use.

Applications of estuarine technology

Advancing technology contribute to a better understanding of estuarine ecosystems, aid in conservation efforts, and support sustainable management practices. The integration of modern technology is crucial for addressing environmental challenges and promoting the long-term health of estuarine environments. Examples of critical technologies include:

- Remote Sensing: Satellite imagery and aerial surveys help monitor changes in estuarine environments, and remote sensing technologies provide valuable data on water quality, vegetation, and land-use changes.
- Sensor Networks: Deploying sensor networks in estuarine regions can provide real-time data on parameters such as water temperature, salinity, dissolved oxygen, and nutrient levels. These networks enable continuous monitoring and early detection of changes in the ecosystem.
- GIS (Geographic Information Systems): GIS is used to analyze and visualize spatial data related to estuarine ecosystems, and is a critical tool in understanding the distribution of habitats, identifying vulnerable areas, and planning conservation strategies.
- Modeling: Analytical and numerical models are used to simulate and predict the behavior of estuarine systems. These models incorporate data on hydrodynamics, sediment transport, contaminant transport and ecological processes to better understand how the ecosystem functions and responds to various influences.
- Underwater Vehicles: Autonomous underwater vehicles (AUVs) and remotely operated vehicles (ROVs) are employed to explore and collect data from underwater environments. These vehicles can reach depths and locations that are challenging for human divers.
- DNA Analysis: Genetic technologies are increasingly used to study the biodiversity of estuarine ecosystems. DNA analysis helps identify species, track population dynamics, and assess the impacts of environmental changes.
- Water Treatment Technologies: Technologies for treating estuarine water, such as desalination and water purification systems, play a role in managing water quality for both ecological health and human use.
- Habitat Restoration: Various technologies are used in habitat restoration projects, including the deployment of artificial reefs, the use of bioengineering techniques, and the cultivation of native vegetation to enhance estuarine ecosystems.

Estuarine Management and Technologies accepts the following types of articles:

Research Article, Review Article, Short Communication, Data Paper, Software Description, Editorial, Corrigendum, Methods & Technologies; Estuarine Scientists; Expert View; Video Paper in 180s; Rapid Communication; Mini-Review; Education & Communication.

Specific research areas include:

- Application of Remote Sensing and GIS technology in estuarine studies

- Estuarine bio-resource systems
- Monitoring, remediation, assessment and protection of estuaries
- Planning and management of estuaries towards sustainability
- Development and realization of national and international policies on estuaries
- Estuaries economics
- Contaminant sources, sorption, diffusion, transformation, volatilization and transport
- Physics, chemistry, geology and biology of estuary
- Estuarine pollution and control
- Estuarine water quality assessment
- Ecology and biodiversity of estuaries
- Degradation of estuarine ecosystems and its abatement
- Estuarine ecosystems maintenance and preservation
- Estuary and coastal aquifer interactions
- Micro(nano) plastic detection and remediation in estuaries
- Climate change impacts on estuaries
- Application of artificial intelligence in estuarine studies
- Numerical and Analytical modelling of estuarine processes
- Estuarine circulation
- Estuarine sedimentary processes

In summary, Estuarine Management and Technologies stands as a pioneering scientific journal committed to advancing our comprehension of estuarine management and technologies within environmental contexts. The new journal serves as a valuable platform for disseminating original and globally influential scientific research, with the overarching goal of fostering collaboration and facilitating knowledge sharing among researchers in this specialized field.

By providing an avenue for the publication of cutting-edge research in technological advancements and management strategies of estuaries, the journal positions itself at the forefront of adynamic and rapidly evolving field. As we navigate the complexities of environmental challenges, Estuarine Management and Technologies endeavors to contribute to the collective knowledge base, enabling innovation and sustainable practices in the management of estuarine ecosystems. Through the exchange of ideas and the dissemination of groundbreaking research, this journal can play a vital role in shaping the future of estuarine science and technology.

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Additional information

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Data availability

All of the data that support the findings of this study are available in the main text.